RE-ORDER NO. 64-146

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NASA CR 56173

FINAL REPORT

JET PROPULSION LABORATORY

MARINER "C" Exit Optics Assembly and Cooling System

JPL Contract No. 950548

6 April 1964

OTS PRICE

XEROX $ 1.60

MICROFILM $

SBRC

SANTA BARBARA RESEARCH CENTER

A Subsidiary of HUGHES Aircraft Company

SANTA BARBARA RESEARCH CENTER
A Subsidiary of Hughes Aircraft Company
75 COROMAR DRIVE • GOLETA, CALIFORNIA
TELEPHONE: 968-3511

6 April 1964

TO: Jet Propulsion Laboratory
4800 Oak Grove Drive
Pasadena, California

Attention: J. F. Greenhalgh

SUBJECT: JPL Contract No. 950548
Final Report

OBJECTIVE

End requirements of this program required SBRC to design,

1. An exit optics assembly and deliver two complete units.
2. Design a refrigeration assembly.
3. Deliver ten (10) exit optics assembly kits consisting of items purchased prior to reduction in number of item I units.
4. Instrument record of the exit optics assemblies.
5. One vellum and six (6) copies of the drawings of the above Items 1 and 2.
6. One vellum and six (6) copies of test specification for the SBRC conducted exit optics assembly test.

INTRODUCTION

Original requirements for 12 flight models of Item 1 and 2 above were modified by JPL due to program changes which removed the emphasis for early delivery. Subsequently excess funds were needed by JPL for other programs so only those funds were left to perform the above tasks within the limitation of the funds.

The original quantities for items required from outside vendors were ordered prior to the change in scope and are to be delivered as parts of Item 3 kits. (Extra cryostats were not fabricated above the needs for the two assemblies of Item 1.)

SBRC

TECHNICAL REPORT

Detectors

Due to long wavelength design requirements of the PbSe immersed detector, IRTRAN-2 lens were required. Since SBRC had not used this material for detector substrates previously some trouble was experienced in matching performance of detectors deposited on normally used substrates. Some changes in chemistry did result in detectors capable of meeting the design goals by providing a geometrical shield although the yield of acceptable detectors was low. Trial runs were made on coating the immersed lens by spin coating techniques but anti-reflection coatings were not used due to the narrowing of the spectral response in the long wavelength region.

Refrigeration Assembly

The quick cool down design originally required a higher pressure starting tank, a sustaining tank combined with a dual wound cryostat with a quick starting coil and sustaining coil. Two gas filters were also required. After the change in scope, a single wound cryostat and two gas filters for each assembly were delivered as a part of each detector and optics assembly.

Pressure tests with hydraulic oil were conducted on the gas filter assemblies with the following results:

- Sample 1 - failed at the brazed joint at 21,600 psi.
- Sample 2 - failed in the connecting tubing at 23,000 psi and again at the connecting tubing at 22,500 psi but the filter did not burst.
- Sample 3 - developed a pin hole leak at the brazed joint at 20,400 psi.

The filter bodies destined for end use were proof tested at 7,900 psi at 24°C with nitrogen gas.

Optical Design

The optical path of the PbSe detector has the incident radiation first passing through the dichroic beam splitter at 45° to the surface with an average transmission of 85% in the 4.95 to 6.6 micron bandwidth. The second optical

Optical Design con't.

unit is the mirror attached to the PbSe detector housing with a reflectance of about 95%. The silicon lens on the detector package has an average transmission of 90%. Thus the percentage of incident radiation reaching the front surface of the immersed PbSe detector amounts to 73% in the spectral bandwidth 4.95 to 6.6 microns.

The optical path of the PbS detector has the reflected radiation from the front surface of the dichroic beam splitter which has an average reflectance of 91% in the 1.65 to 2.2 micron bandwidth. The second optical component is an interference filter of 70% average transmission in the 1.65 to 2.2 micron bandwidth with an aperture vacuum deposited on the front surface.

The silicon lens on the front of the PbS detector package has an average transmission of 95%. Thus the percentage of incident radiation reaching the front of the immersed PbS detector amounts to 61.0% in the 1.65 to 2.2 micron bandwidth.

Spectral curves of the above optical elements follow.

A. Transmission curve of Dichroic Beam Splitter.

B. Reflection curve of Dichroic Beam Splitter.

C. Transmission curve of Silicon Lens for PbSe detector.

D. Transmission curve of Silicon Lens for PbS detector.

E. Transmission curve for 1.65 to 2.2 micron interference filter for PbS detector.

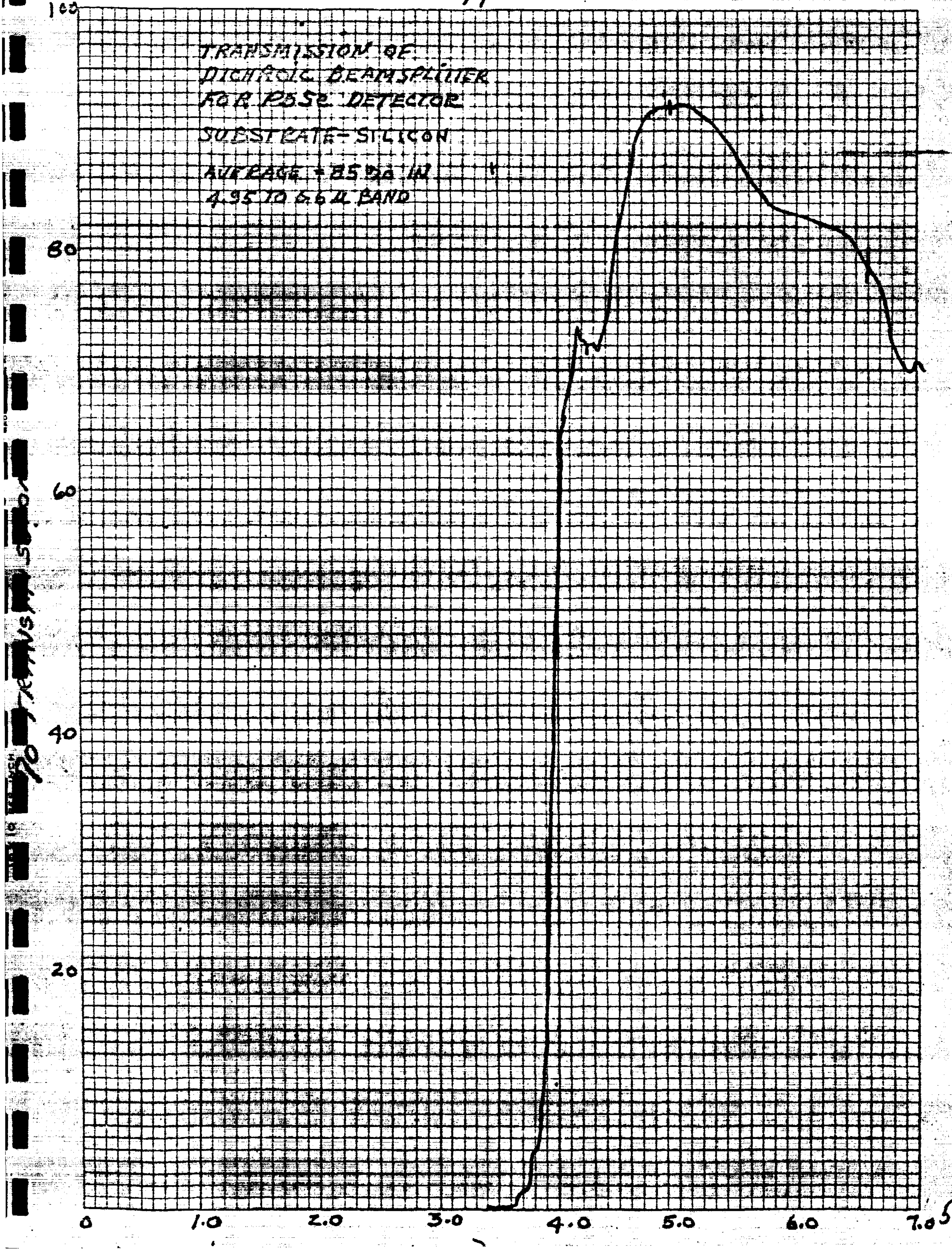
F. Spectral response of PbS detector used in assembly #2 with 1.65 to 2.2 micron filter and .155 aperture over detector.

G. Spectral response of PbSe detector used in assembly #2 with .155 aperture over detector and calculated response through Dichroic Beam Splitter.

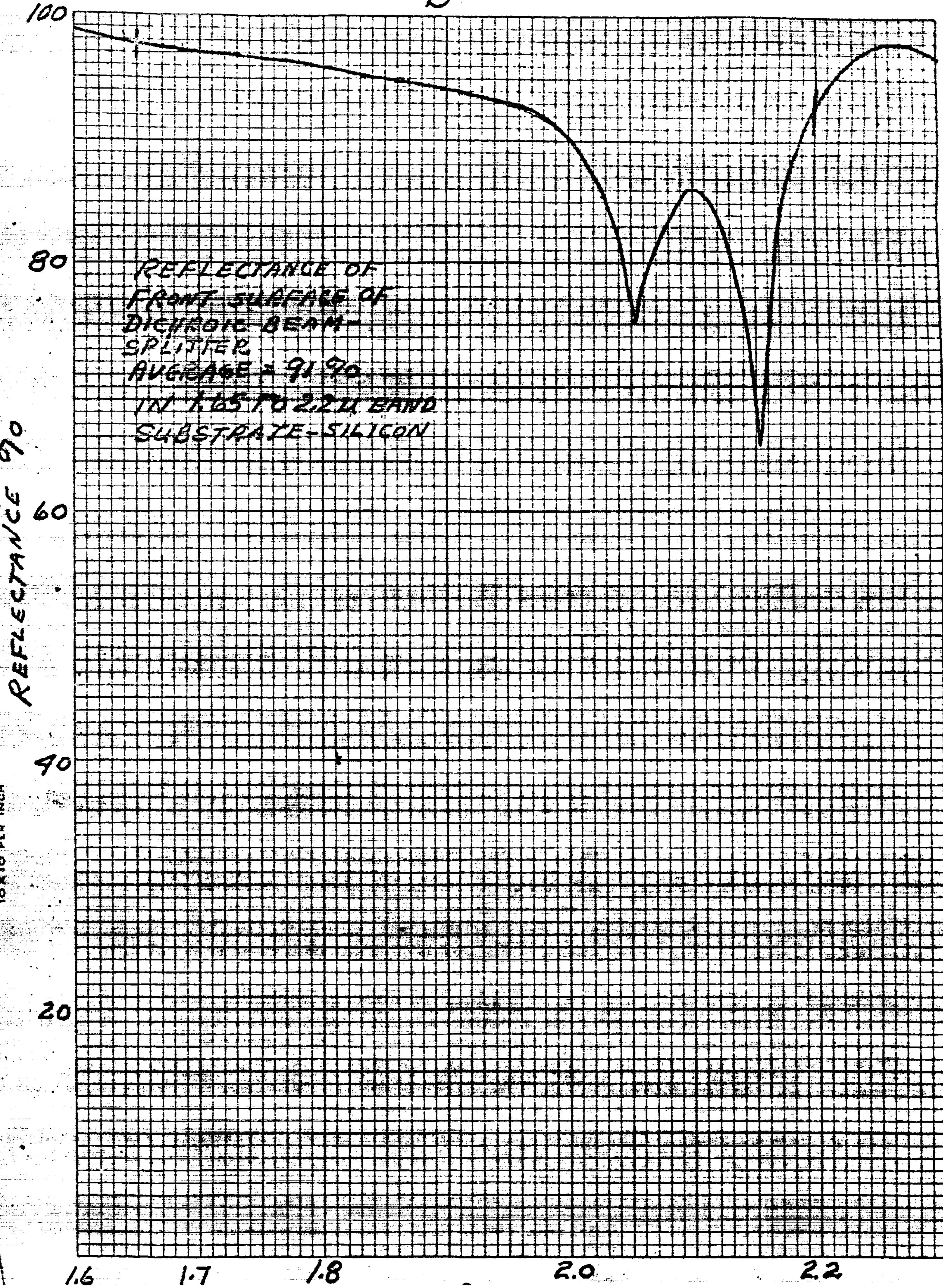
J. J. Long
J. J. Long
Project Manager

R M Talley
R. M. Talley
Manager, Santa Barbara Laboratory

"A"

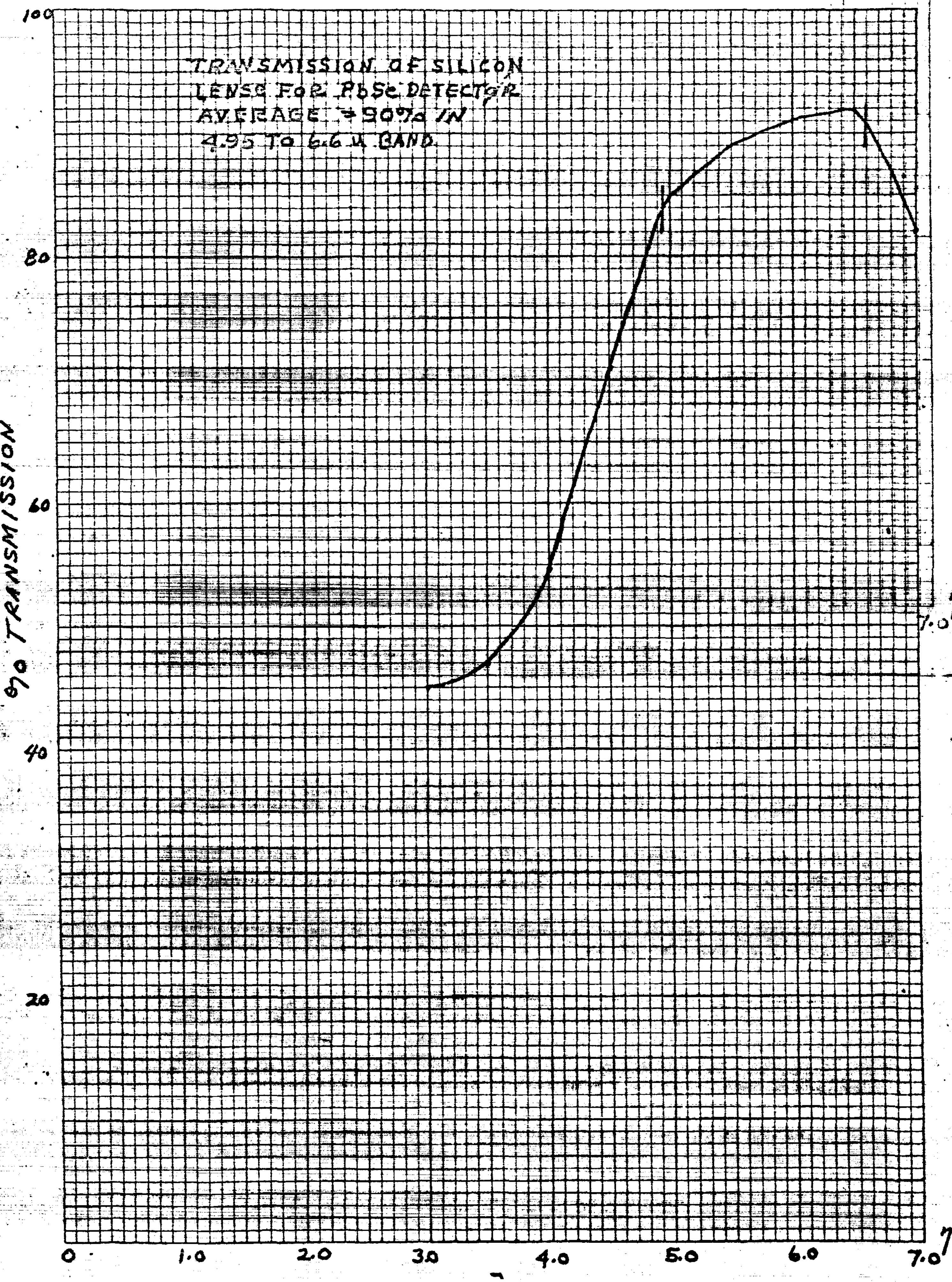

TRANSMISSION OF
DICHROIC BEAMSPLITTER
FOR PbSe DETECTOR
SUBSTRATE - SILICON
AVERAGE = 85% IN
4.95 TO 6.6μ BAND
% Transmission
100
80
60
40
20
0
1.0
2.0
3.0
4.0
5.0
6.0
7.0

"B"

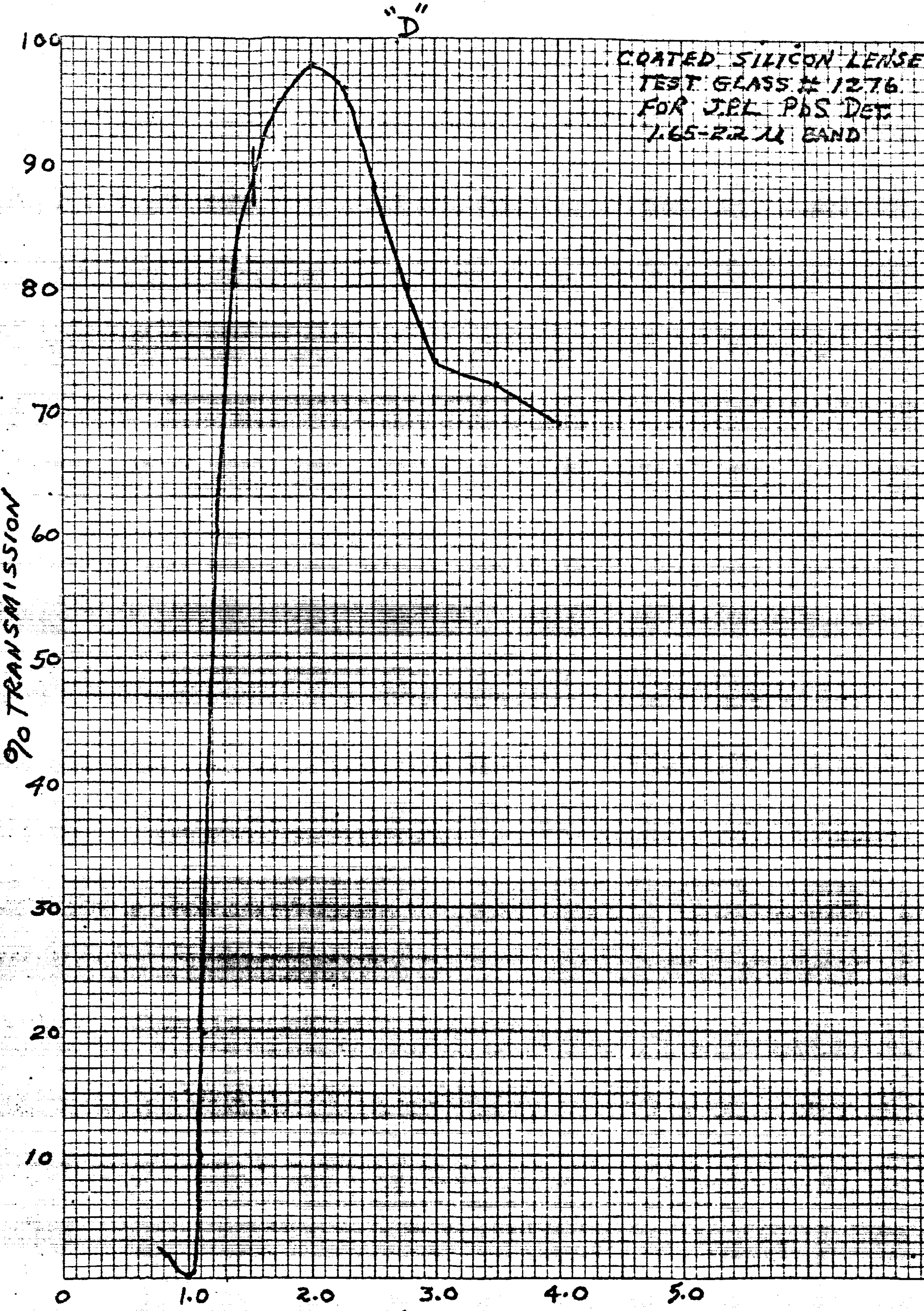


100
80
60
40
20
REFLECTANCE %
REFLECTANCE OF
FRONT SURFACE OF
DICHROIC BEAM-
SPLITTER
AVERAGE = 91 %
IN 1.65 TO 2.2 μ BAND
SUBSTRATE-SILICON
1.6
1.7
1.8
2.0
2.2

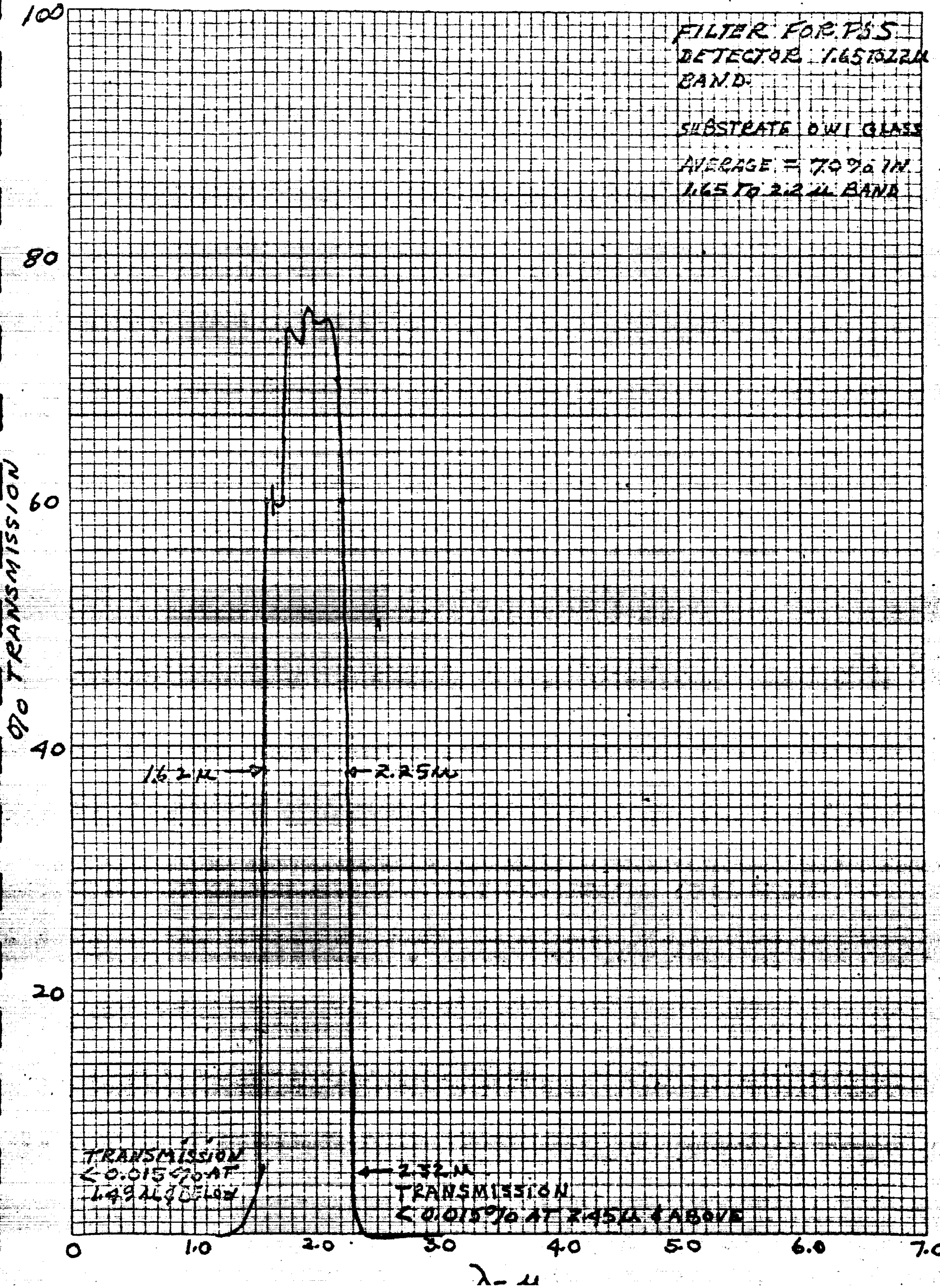
"C"



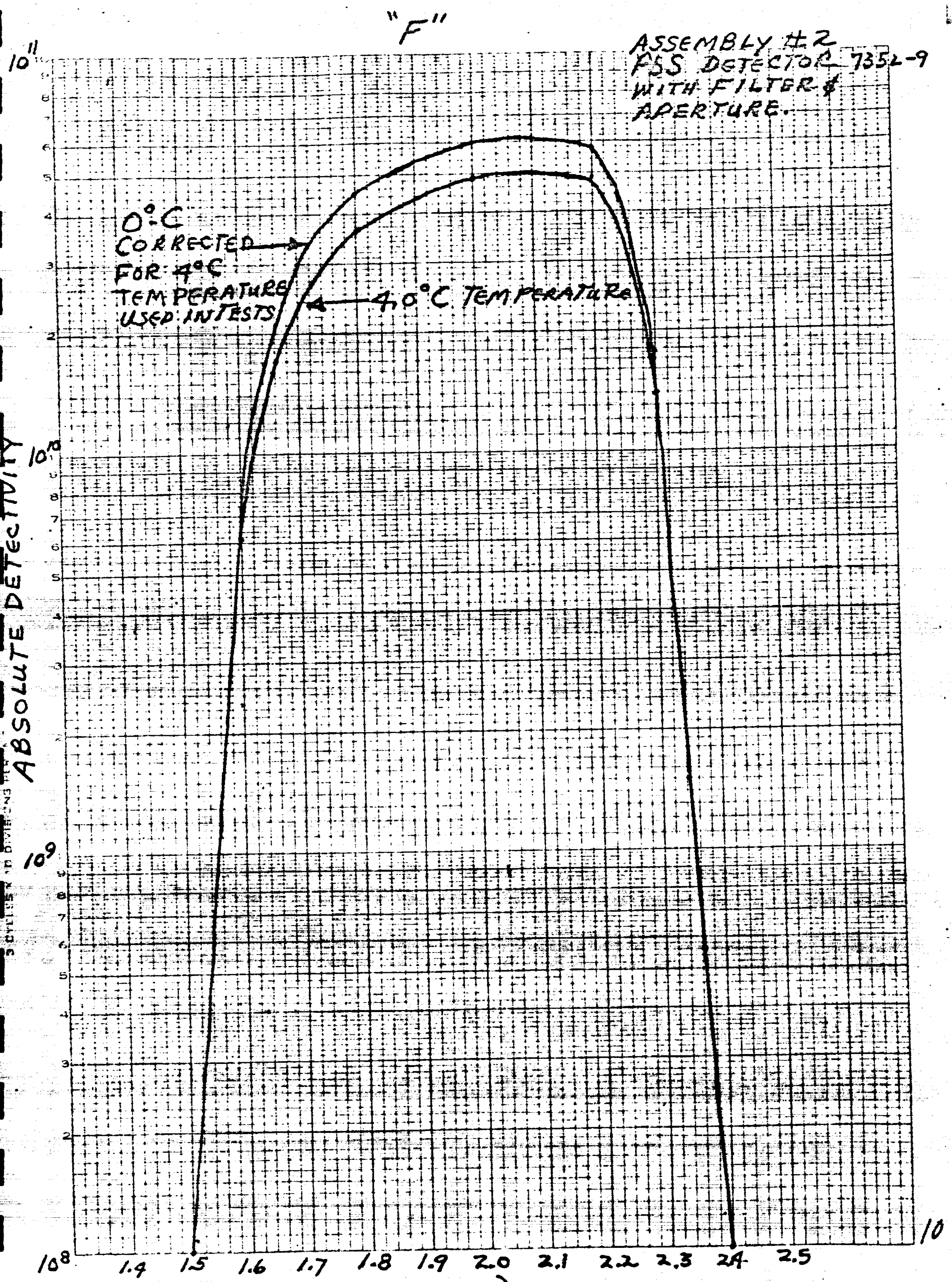
TRANSMISSION OF SILICON
LENSE FOR PbSe DETECTOR
AVERAGE ≈90% IN
4.95 TO 6.6 μ BAND
% TRANSMISSION
100
80
60
40
20
0
1.0
2.0
3.0
4.0
5.0
6.0
7.0


"D"
COATED SILICON LENSE
TEST GLASS # 1276
FOR J.P.L. PbS DET.
1.65-2.2 μ BAND
% TRANSMISSION
100
90
80
70
60
50
40
30
20
10
0
1.0
2.0
3.0
4.0
5.0

"E"

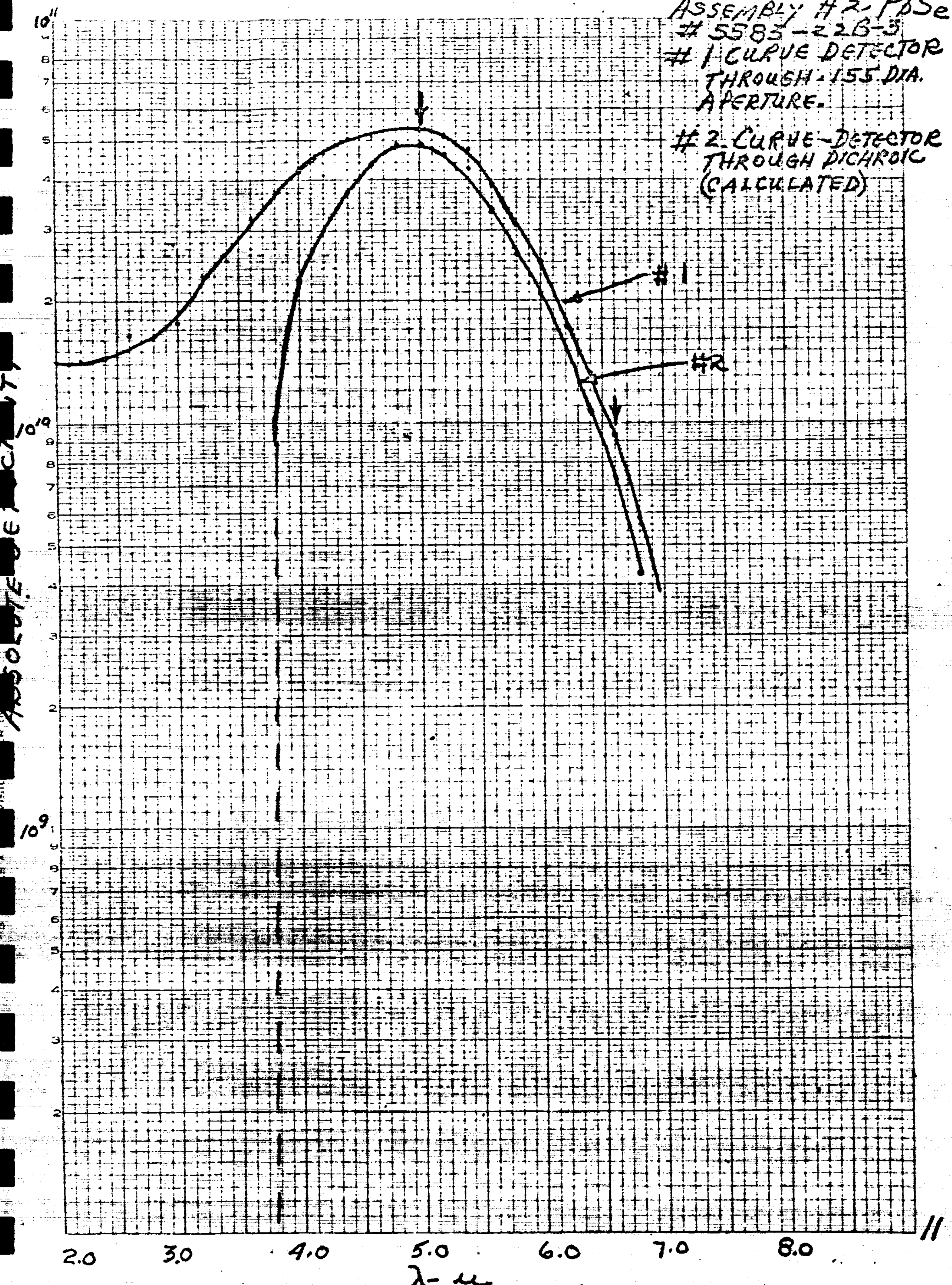


FILTER FOR PSS
DETECTOR 1.65 TO 2.2 μ
BAND.
SUBSTRATE OWI GLASS
AVERAGE = 79% IN
1.65 TO 2.2 μ BAND
100
80
60
40
20
% TRANSMISSION
1.62 μ
2.25 μ
TRANSMISSION
< 0.015% AT
1.49 μ & BELOW
2.32 μ
TRANSMISSION
< 0.015% AT 2.45 μ & ABOVE
0
1.0
2.0
3.0
4.0
5.0
6.0
7.0
λ - μ



"F"
ASSEMBLY #2
FSS DETECTOR 735L-9
WITH FILTER &
APERTURE.
0°C
CORRECTED
FOR 4°C
TEMPERATURE
USED IN TESTS
40°C TEMPERATURE
ABSOLUTE DETECTIVITY
10^11
10^10
10^9
10^8
1.4
1.5
1.6
1.7
1.8
1.9
2.0
2.1
2.2
2.3
2.4
2.5
10

G


ASSEMBLY #2 PbSe
#5583-22B-3
#1 CURVE DETECTOR THROUGH .155 DIA. APERTURE.
#2 CURVE-DETECTOR THROUGH DICHROIC (CALCULATED)
#1
#2
10^{11}
10^{10}
10^{9}
2.0
3.0
4.0
5.0
6.0
7.0
8.0
λ- μ

SANTA BARBARA RESEARCH CENTER

QUALITY ASSURANCE DEPARTMENT

ENVIRONMENTAL TEST PROCEDURE NO. 2090-4

QUALITY ENGINEER	___	CONTRACT NO:	950548-Modification No. 1
APPROVED	___ Project Engineer	PART NAME:	Exit Optics Assembly
APPROVED	___ Director, Quality Assurance	CLASS OF TEST:	Type Approval Test
		REFERENCE:	JPL Specification No. 30250A

1.0 PURPOSE: To determine the environmental integrity of the assembly as a function of vacuum-temperature changes.

2.0 REFERENCE PARAGRAPH: 4.4.2.1.2

3.0 MATERIAL:

a. Exit Optics Assembly.

4.0 TOOLS AND EQUIPMENT:

a. Vacuum coating unit, Type LCI - 18 B, 18" x 30" bell jar. Consolidated Vacuum Corp.

b. Simpson Multimeter, Model 260.

5.0 TEST PROCEDURE:

a. The test shall be conducted in a vacuum chamber at a pressure of 10^{-4} mm of Hg or less.

b. The temperature shall be controlled by regulating the radiative environment inside the vacuum chamber.

c. The test is to be conducted in a vacuum chamber with a cold-wall and heat lamps for the temperature control mechanisms.

d. The assembly when placed in the vacuum chamber, shall be suspended in such a manner as to insure thermal insulation from the cold-wall.

e. A heat lamp shall be placed so that the assembly will be irradiated from at least two directinns. Use aluminum foil as a reflector.

f. The temperature of the cold-wall is reduced so that the assembly cools by radiation and the heat lamps are operated so that the net effect of irradiation and cooling controls the equilibrium temperature of the assembly.

g. The assembly shall be placed into the test chamber and the external temperature of the assembly lowered to -75°C and held for four hours after allowing .5 hours of stabilization time.